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(54) SEMI-SUBMERGED SAIL SHIP

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ABSTRACT

A cargo carrying vessel which is provided with an elongated bulbous pressure hull designed to operate in a semi-submerged state. The vessel is provided with one or more rigid wing sails to aid propulsion and solar cell arrays are mounted on each wing sail to generate electrical energy. The electrical energy is used to power an electric motor which drives the vessel in conventional manner. Excess energy may be stored in banks of storage batteries which form part of the internal ballasting of the vessel.

This invention relates to a semi-submerged cargo vessel and more particularly a sail-assisted semi-submerged cargo vessel.

Submerged and semi-submerged sea going vessels which are capable of carrying cargo are relatively well known in the art. Many submarines have been developed over the ages using various forms of motive power including diesel and gasoline engines and more recently electric and nuclear engines. Because these vessels are designed to withstand considerable water pressures, special techniques and equipment for operation are required. Semi-submerged vessels, and in particular flexible bulk gas and oil carriers, have also been designed generally for towing astern of conventional surface vessels.

Rigid wing sails are also known to the art for propulsion of relatively light sport-sail boats (see, for example, U. S. Patent 2,487,687) but, as far as is known, it has not been suggested that a semi-submerged cargo carrying vessel should be provided with wing sails to aid the propulsion thereof.

Solar cells for the production of electrical energy are also known to the art, see, for example, U. S. Patent 3,410,086, particularly in space craft where they are generally deployed on rigid wing-like structures to achieve maximum solar exposure. It has not, however, been suggested that solar cells may be incorporated into wing sails for ship propulsion.

It is an object, therefore, of the present invention to provide a novel semi-submersible cargo carrying vessel which is provided with wing sails to assist propulsion and wherein the rigid wing sails incorporate solar cell

arrays to generate power which is used for additional propulsion needs either directly to an electric motor or via storage batteries.

Thus, by one aspect of this invention there is provided a cargo carrying vessel comprising (a) a hull adapted to float with a major proportion thereof beneath the surface of an aqueous medium; (b) at least one substantially rigid wing sail member pivotally mounted on said hull; (c) solar cell means disposed on said sail member for generating electrical energy; (d) motor means, powered by said electrical energy; and (e) drive means operatively connected to said motor means for propelling said vessel through said aqueous medium.

The invention will be described in more detail hereinafter with reference to the drawings in which:

Fig. 1 is a side elevation of one embodiment of the sail ship of the present invention;

Fig. 2 is a plan view of the ship of Fig. 1;

Fig. 3 is a front view of the ship of Fig. 1; and

Fig. 4 is a sectional view of an alternative embodiment of the present invention, showing an internal ballasting arrangement, resulting in a slightly modified hull shape.

In Fig. 1, there is shown an elongated, bulbous semi-submersible hull 1 designed to float in a substantially submerged position in an aqueous medium, such as sea water, using external (Fig. 3), internal (Fig. 4) ballasting and trim tanks to maintain the centre of gravity at the desired level. The hull is substantially completely enclosed and is designed to withstand considerable pressure, in the manner of a conventional submarine. The superstructure 2 is relatively small compared to the hull, in the manner of a conventional conning-tower of a submarine, and is relatively narrow and high. The sides 3, 4 of the superstructure are inwardly curved in order to disperse the force of crashing waves. The deck 5 is narrow and relatively high above the water line, thereby avoiding breaking seas in all but the heaviest weather.

In the embodiments shown, the ship is provided with four rigid steel telescopic masts 6, 7, 8 and 9, each carrying three substantially rigid wing sails 10, 11, 12, known per se, the upper sections being designed to telescopically retract into the lower section. The number of masts and sails is not, of course, critical but merely a matter of convenience.

It will be appreciated that sail 12 retracts into sail 11 and said 11 retracts into sail 10. In very heavy seas with the sail area reduced by retraction of the upper sections and by moving the wing sails into a neutral position relative to the ambient wind, the vessel is practically enabled to lie ahull. The lateral thrust of the masts 6, 7, 8 and 9 and sails 10, 11 and 12 is balanced by a relatively deep ballasted keel 13 (Figs. 1, 2 and 3) or by internal ballasting and a modified internal keel form 14 (Fig. 4). Bilge keels 15 and a skeg 16 may also be provided, depending upon the particular design characteristics required.

The masts, which are preferred but not essential to the invention as the rigid wing sails may be mounted in alternative ways, and sails are pivotally mounted through the superstructure 2 so that the sails 10, 11, 12 may be trimmed in conventional manner to provide forward propulsion of the vessel. The sails 10, 11 and 12 are also provided with arrays of solar panels 25 which generate electrical power, in a manner known per se, at least during daylight hours when the sun is shining. Power generated thereby is used by an electric motor 26 which drives a variable-pitch double propeller 17. Any excess power generated may be stored in storage batteries 18, which form part of the solid internal ballast of the vessel, for subsequent use for propulsion or general utility aboard the vessel. It will be appreciated that, for safety considerations, a conventional diesel or similar engine may be installed for emergency propulsion.

As will be seen most clearly in Fig. 4, the bulbous nature of the hull 1 makes docking at a conventional dock relatively difficult and

recourse is best made to the use of a retractable jetty 19 for access to the top deck 5, or to hydraulic self-docking devices and gangways. Retractable port holes 20, 21 may be provided in sloping walls 3 and 4 of the superstructure to facilitate cargo handling to the lower decks and holds of the vessel. An elevator 22 may also be provided for cargo and personnel carrying as required.

The vessel is designed for movement through the water in the semi-submerged position as shown in Fig. 1 and clearly when in ballast will tend to ride high in the water. This tendency may be eliminated by flooding the flood tanks 23, which are located around the hold 24 and form part of the internal ballasting of the vessel.

The vessel of the present invention may, of course, be modified in many ways without departing from the scope of the invention, the purpose of which is to provide a structurally safe and smooth mode of transportation and to provide an environmentally acceptable solution to the problem of heavy cargo handling, substantially without the use of expensive fossil fuels.

The present vessel may best be described as a sail assisted electro-ship which utilizes both wind and solar energy to provide its motive power. It is to be stressed, however, that the vessel of the present invention is not designed to be operated in the fully submerged mode of a submarine as the centre of gravity is always considerably below the centre of buoyancy of the vessel. It will be appreciated that in a conventionally buoyant mode, the vessel is pressing against the water surface from above, which exposes the vessel to every sort of hydrodynamic hardship; whereas in the semi-submerged buoyant mode, the vessel is pressing against the water surface from below, which reduces the hydrodynamic problems by a factor which may be as high as 50%.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A cargo carrying vessel comprising:

(a) a hull adapted to float with a major proportion thereof beneath the surface of an aqueous medium;

(b) at least one substantially rigid wing sail member pivotally mounted on said hull;

(c) solar cell means disposed on said sail member for generating electrical energy;

(d) motor means, powered by said electrical energy; and

(e) drive means operatively connected to said motor means for propelling said vessel through said aqueous medium.

2. A vessel as claimed in claim 1 wherein said wing sail member comprises at least two sections, one of which is retractable into the other.

3. A vessel as claimed in claim 2 including a plurality of masts each having at least one said rigid wing sail member mounted thereon.

4. A vessel as claimed in claim 1, 2 or 3 including energy storage means, operatively connected to said solar cell means.

5. A vessel as claimed in claim 1, 2 or 3 including external ballast keel means.

6. A vessel as claimed in claim 1, 2 or 3 including internal ballast keel means.

7. A vessel as claimed in claim 1, 2 or 3 including means to control the centre of gravity of said vessel.

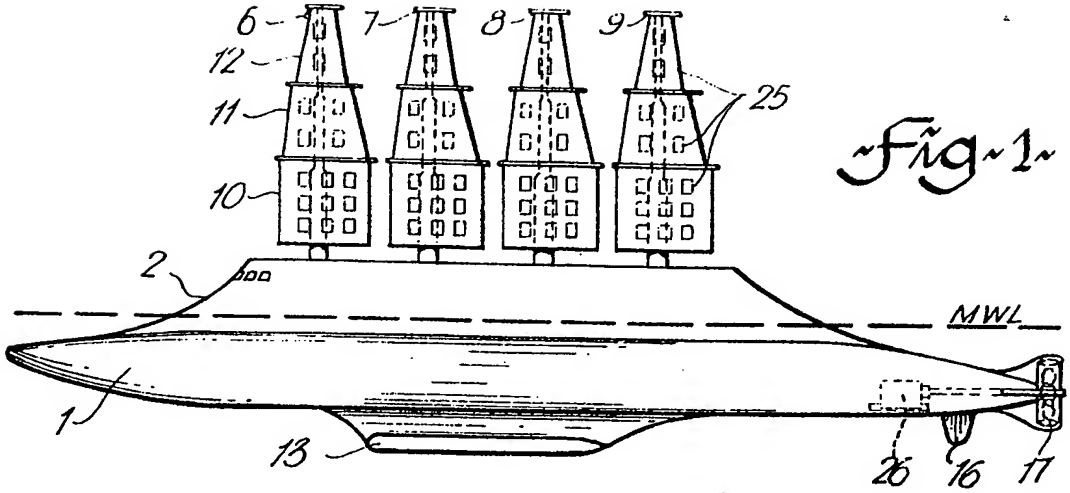

Fig 1

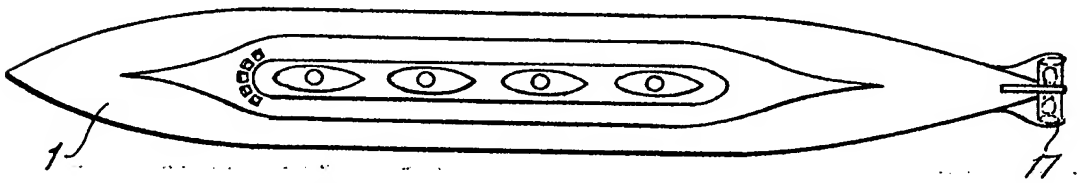

Fig 2

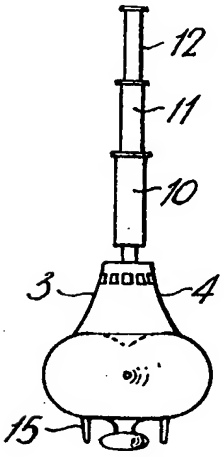

Fig 3

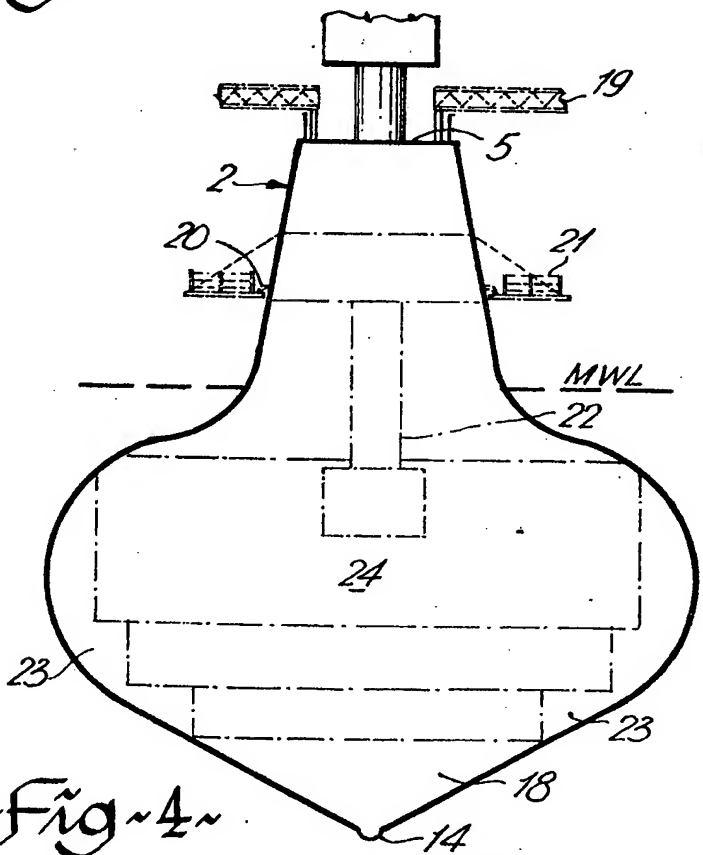

Fig 4

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